[0016] In order to solve the problems considered, the biodegradable wrap film of the present invention is a biodegradable wrap film, comprising, as the main component, a lactic acid resin composition comprising a plasticizer and a poly(DL-lactic acid) in which the proportion of L--isomer and D-isomer is 88:12 to 85:15 or 12:88 to 15:85, comprising, the lactic acid resin composition with a value of storage modulus at 40°C in the range of 100 MPa to 3 GPa as measured at a frequency of 10 Hz and a distortion of 0.1% by the dynamic viscoelasticity testing method from Method A of JIS K-7198 (corresponding to ISO 6721-4; Method A of JIS K-7198 defined on 1 November 1991 is currently replaced by JIS K-7244-4 defined on 20 October 1999), a value of storage modulus at 100°C in the range of 30 MPa to 500 MPa, and a peak value of loss tangent (tan δ) in the range of 0.1 to 0.8.

[0032] Regarding the DL constitution ratio in poly(DL-lactic acid), for instance, L-isomer:D-isomer = 100:0 to 85:15, or L-isomer:D-isomer = 0:100 to 15:85 is preferred; more preferable from the view point of plasticizer bleed- out is a composition that is less crystalline than at least the L-isomer:D-isomer = 88:12 used in the following Examples 4 to 6, namely, L-isomer:D-isomer = 88:12 to 85:15, or L-isomer:D-isomer = 12:88 to 15:85.

Although a homopolymer is ideally a polymer comprising 100% L-lactic acid or D-lactic acid, as there is the possibility that a different lactic acid is incorporated unavoidably during polymerization, in the present invention, a polymer containing 98% or more L-lactic acid or D-lactic acid is referred to as a homopolymer.

WHAT IS CLAIMED IS:

1. (Amended) A biodegradable wrap film, which is a biodegradable wrap film comprising as a main component a lactic acid resin composition comprising a poly(DL-lactic acid) in which the proportion of L-isomer and D-isomer is 88:12 to 85:15 or 12:88 to 15:85, and a plasticizer, the lactic acid resin composition, wherein

the value of storage modulus at 40°C is in the range of 100 MPa to 3 GPa as measured at a frequency of 10 Hz and a distortion of 0.1% by the dynamic viscoelasticity testing method from Method A of JIS K-7198,

the value of storage modulus at 100°C is in the range of 30 MPa to 500 MPa, and

the peak value of loss tangent (tan δ) is in the range of 0.1 to 0.8.

2. The biodegradable wrap film as recited in Claim 1, wherein the value of storage modulus at 20°C is in the range of 1 GPa to 4 GPa, as measured at a frequency of 10 Hz and a distortion of 0.1% by the dynamic viscoelasticity testing method from Method A of JIS K-7198, and the value of loss tangent (tan δ) at 20°C is 0.5 or less.

3. The biodegradable wrap film as recited in Claim 1 or 2, wherein the value of storage modulus at 60°C is in the range of

100 MPa to 800 MPa as measured at a frequency of 10 Hz and a distortion of 0.1% by the dynamic viscoelasticity testing method from Method A of JIS K-7198.

4. The biodegradable wrap film as recited in any of Claims 1 to 3, wherein the lactic acid resin composition comprises a lactic acid resin and a plasticizer in a proportion of 60:1 to 99:1 by mass.

5. The biodegradable wrap film as recited in any of Claims 1 to 4, wherein the difference ($\Delta Hm - \Delta Hc$) is 10 J/g or more between ΔHm, the heat of melting required to melt the crystals completely when heating the film according to JIS K-7121 at a heating rate of 10°C/minute using a differential scanning calorimeter, and ΔHc, the heat of crystallization produced concomitantly with crystallization during the heating.

6. The biodegradable wrap film as recited in any of Claims 1 to 5, wherein the formed film is heated at a temperature between the glass transition temperature when heating according to JIS K-7121 at a heating rate of 10°C/minute using a differential scanning calorimeter, and the peak temperature of the heat of crystallization produced concomitantly with crystallization during the heating, and cured for 6 hours or longer.

[0083]

[Table 1]

	Composition	Storage Modulus			Peak Value of Loss Tangent	Loss Tangent	ΔHm-ΔHc	Stress Ratio	Ability to be Cut	Heat Resistance	Wrapping Suitability	Bleed Acceleration Test
		20°C MPa	40°C MPa	100°C MPa	–	20°C –	J/g	–				
Reference Example 1	NW4031/TEC=70/30 60°C×24 hours curing	2060	1200	204	0.15	0.08	41	1.16	○	○	△	×
Reference Example 2	NW4050/TEC=85/15 60°C×24 hours curing	2020	774	125	0.2	0.13	32.3	1.18	○	○	○	×
Reference Example 3	NW4050/PX884=90/10 60°C×24 hours curing	2400	1200	167	0.19	0.07	30.1	1.08	○	○	△	△
Example 1	NW4060/PX884=90/10 60°C×24 hours curing	1990	747	88	0.24	0.12	21	1.09	○	○	○	○
Example 2	NW4060/PX884=85/15 60°C×24 hours curing	1070	433	66	0.2	0.16	21	1.08	○	○	○	○
Example 3	NW4060/PX884=93/7 60°C×24 hours curing	3250	1260	94	0.27	0.06	20	1.1	○	○	△	○
Reference Example 4	NW4031/NW4050/TEC=50/50/40 60°C×24 hours curing	1290	1930	250	0.2	0.16	32	1.02	○	○	○	×
Reference Example 5	NW4031/NW4050/NW4060/TEC=45/45/10/30 60°C×24 hours curing	3100	1970	230	0.17	0.045	34	1.2	○	○	△	△
Comparative Example 1	NW4031/TEC=70/30	1920	21	110	2.6	0.15	5.1	1.02	×	○	○	×
Comparative Example 2	NW4060/PX884=90/10	2450	350	–	3.1	0.052	0	1.06	△	×	○	○
Comparative Example 3	NW4060/PX884=85/15	1990	11	13	2.3	0.15	0	1.03	×	×	○	○
Comparative Example 4	NW4060/PX884=93/7	2980	1620	20	1	0.03	0	1.05	○	×	×	○

(Reference Example 1)

The lactic acid resin NatureWorks 4031D (molecular weight: 200,000), which is a poly(L-lactic acid) with a proportion of L-isomer:D-isomer = 99:1 manufactured by Cargill Dow, and 0.1 phr of aluminum stearate as lubricant were mixed, then melted and extruded at 190°C and 200 rpm using a 40 mmΦ mini co-rotating twin-screw extruder manufactured by Mitsubishi Heavy Industries Co., Ltd., while injecting from the vent opening 30 wt% in mass ratio of triethyl citrate as plasticizer (CITROFLEX 2 (TEC in the table); molecular weight: 270; SP value: 11.46 [fedors method]; manufactured by Morimura Bros., Inc.), and a 10 μm film was formed at a temperature of 200°C by the casting method, which was then cured at 60°C for 24 hours.

(Reference Example 2)

The lactic acid resin NatureWorks 4050 (molecular weight: 200,000), which is a poly(DL-lactic acid) with a proportion of L-isomer:D-isomer = 95:5 manufactured by Cargill Dow, and 0.1 phr of aluminum stearate as lubricant were mixed, then melted and extruded at 190°C and 200 rpm using a 40 mmΦ mini co-rotating twin-screw extruder manufactured by Mitsubishi Heavy Industries Co., Ltd., while injecting from the vent opening 15 wt% in mass ratio of triethyl citrate as plasticizer (CITROFLEX 2 (TEC in the table); molecular weight: 270; SP value: 11.46 [fedors method]), and a 10 μm film was formed at a temperature of 200°C by the casting method, which was then cured at 60°C for 24 hours.

(Reference Example 3)

The lactic acid resin NatureWorks 4050 (molecular weight: 200,000), which is a poly(DL-lactic acid) with a

proportion of L-isomer:D-isomer = 95:5 manufactured by Cargill Dow, and 0.1 phr of aluminum stearate as lubricant were mixed, then melted and extruded at 190°C and 200 rpm using a 40 mmΦ mini co-rotating twin-screw extruder manufactured by Mitsubishi Heavy Industries Co., Ltd., while injecting from the vent opening 10 wt% in mass ratio of adipic acid ester (PX-884; molecular weight: 650; SP value: 11.3 [fedors method]; manufactured by Asahi Denka Co., Ltd.), and a 10 μm film was formed at a temperature of 200°C by the casting method, which was then cured at 60°C for 24 hours.

(Example 1)

The lactic acid resin NatureWorks 4060 (molecular weight: 190,000), which is a poly(DL-lactic acid) with a proportion of L-isomer:D-isomer = 88:12 manufactured by Cargill Dow, and 0.1 phr of aluminum stearate as lubricant were mixed, then melted and extruded at 190°C and 200 rpm using a 40 mmΦ mini co-rotating twin-screw extruder manufactured by Mitsubishi Heavy Industries Co., Ltd., while injecting from the vent opening 10 wt% in mass ratio of adipic acid ester (PX-884; molecular weight: 650; SP value: 11.3 [fedors method]; manufactured by Asahi Denka Co., Ltd.), and a 10 μm film was formed at a temperature of 200°C by the casting method, which was then cured at 60°C for 24 hours.

(Example 2)

The lactic acid resin NatureWorks 4060 (molecular weight: 190,000), which is a poly(DL-lactic acid) with a proportion of L-isomer:D-isomer = 88:12 manufactured by Cargill Dow, and 0.1 phr of aluminum stearate as lubricant were mixed, melted and extruded at 190°C and 200 rpm using a 40 mmΦ mini co-rotating twin-screw extruder manufactured

by Mitsubishi Heavy Industries Co., Ltd., while injecting from the vent opening 15 wt% in mass ratio of adipic acid ester (PX-884; molecular weight: 650; SP value: 11.3 [fedors method]; manufactured by Asahi Denka Co., Ltd.), and a 10 μm film was formed at a temperature of 200°C by the casting method, which was then cured at 60°C for 24 hours.

(Example 3)

The lactic acid resin NatureWorks 4060 (molecular weight: 190,000), which is a poly(DL-lactic acid) with a proportion of L-isomer:D-isomer = 88:12 manufactured by Cargill Dow, and 0.1 phr of aluminum stearate as lubricant were mixed, then melted and extruded at 190°C and 200 rpm using a 40 mmΦ mini co-rotating twin-screw extruder manufactured by Mitsubishi Heavy Industries Co., Ltd., while injecting from the vent opening 7 wt% in mass ratio of adipic acid ester (PX-884; molecular weight: 650; SP value: 11.3 [fedors method]; manufactured by Asahi Denka Co., Ltd.), and a 10 μm film was formed at a temperature of 200°C by the casting method, which was then cured at 60°C for 24 hours.

(Reference Example 4)

The lactic acid resin NatureWorks 4031D (molecular weight: 200,000), which is a poly(L-lactic acid) with a proportion of L-isomer:D-isomer = 99:1 manufactured by Cargill Dow, and the lactic acid resin NatureWorks 4050 (molecular weight: 200,000), which is a poly(DL-lactic acid) with a proportion of L-isomer:D-isomer = 95:5 manufactured by Cargill Dow, were dry-blended at a proportion of 4031D:4050 = 50 wt%:50 wt%, mixed with 0.1 phr of aluminum stearate as lubricant, then melted and extruded at 190°C and 200 rpm using a 40 mmΦ mini co-

rotating twin-screw extruder manufactured by Mitsubishi Heavy Industries Co., Ltd., while injecting from the vent opening 40 wt% in mass ratio of triethyl citrate as plasticizer (CITROFLEX 2 ; molecular weight: 270; SP value: 11.46 [fedors method]; manufactured by Morimura Bros., Inc.), and a 10 μm film was formed at a temperature of 200°C by the casting method, which was then cured at 60°C for 24 hours.

(Reference Example 5)

The lactic acid resin NatureWorks 4031D (molecular weight: 200,000), which is a poly(L-lactic acid) with a proportion of L-isomer:D-isomer = 99:1 manufactured by Cargill Dow, the lactic acid resin NatureWorks 4050 (molecular weight: 200,000), which is a poly(DL-lactic acid) with a proportion of L--isomer:D-isomer = 95:5 manufactured by Cargill Dow, and the lactic acid resin NatureWorks 4060 (molecular weight: 190,000), which is a poly(DL-lactic acid) with a proportion of L-isomer:D-isomer = 88:12 manufactured by Cargill Dow, were dry-blended at a proportion of 4031D:4050:4060 = 45 wt%:45 wt%:10 wt%, mixed with 0.1 phr of aluminum stearate as lubricant, melted and extruded at 190°C and 200 rpm using a 40 mmΦ mini co-rotating twin-screw extruder manufactured by Mitsubishi Heavy Industries Co., Ltd., while injecting from the vent opening 30 wt% in mass ratio of triethyl citrate as plasticizer (CITROFLEX 2; molecular weight: 270; SP value: 11.46 [fedors method]; manufactured by Morimura Bros., Inc.), and a 10 μm film was formed at a temperature of 200°C by the casting method, which was then cured at 60°C for 24 hours.

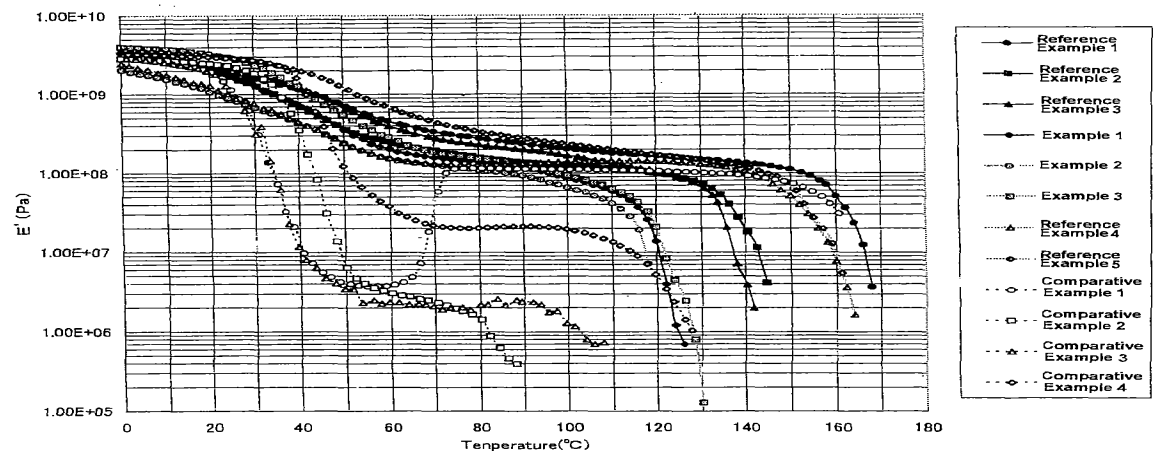
(Bleed Acceleration Test)

The following bleed acceleration test was performed

for the films obtained in the above Examples 1 to 3 and Reference Examples 1 to 5. That is to say, a film with 10 cm in the MD direction and 10 cm in the TD direction, was left in an environment of 40°C and 40%RH for 30 days, and the presence or the absence of plasticizer rising onto the film surface was visually observed.

[0084] The result shows that Examples 1, 2 and 3, and Reference Examples 3 and 5 were better compared to Reference Examples 1, 2, and 4. Among these, Examples 1, 2, and 3 were particularly good without any identification of bleeding at all.

Fig. 1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40
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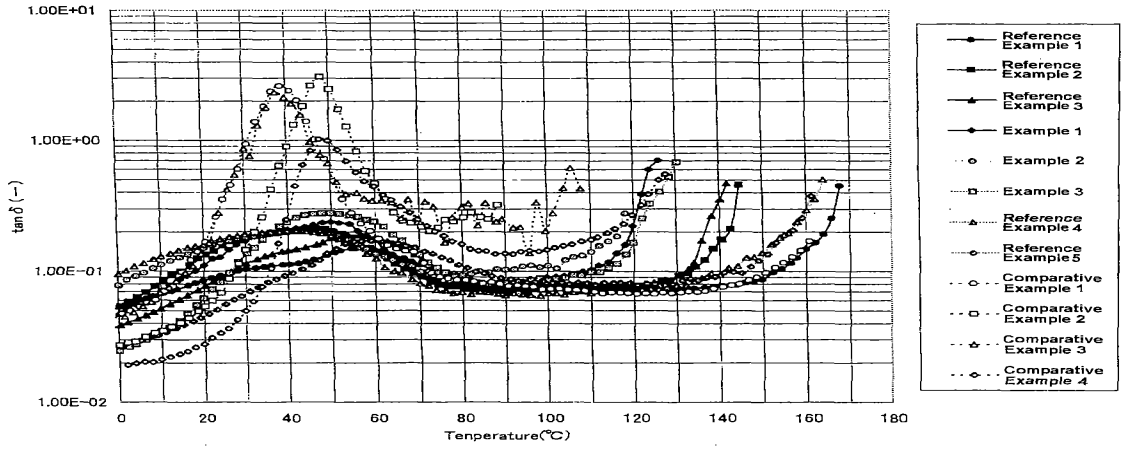
80
100
120
140
160
180
Tenperature(℃)
Reference Example 1
Reference Example 2
Reference Example 3
Example 1
Example 2
Example 3
Reference Example 4
Reference Example 5
Comparative Example 1
Comparative Example 2
Comparative Example 3
Comparative Example 4

Fig. 2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Tenperature(℃)
Reference Example 1
Reference Example 2
Reference Example 3
Example 1
Example 2
Example 3
Reference Example 4
Reference Example 5
Comparative Example 1
Comparative Example 2
Comparative Example 3
Comparative Example 4